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The use of peak flow meters in acute asthma in the emergency department

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THE USE OF PEAK FLOW METERS IN ACUTE ASTHMA IN THE EMERGENCY DEPARTMENT.

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of

Master of Medicine in Emergency Medicine.

Johannesburg, 2014

DECLARATION

I, Pano Parris, declare that this research report is my own work. It is being submitted for the degree of Master of Medicine (Emergency Medicine) in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

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DEDICATION

To Denise, Alexandra, Angelique and Kevin

My loving family who always believed in me, even when I didn't and giving me the love and support to chase my dreams.

ABSTRACT

Objectives: This study aimed to survey and compare the use of the Peak Flow Meter (PFM) with respect to asthma exacerbations in the Emergency Department (ED) by healthcare practitioners from both the private and public sectors attending the Emergency Medicine Society of South Africa symposium.

Design: A questionnaire-based cross-sectional study

Setting: Emergency Medicine Society of South Africa 2012 Symposium in Johannesburg.

Participants: Medical doctors and nursing staff from various EDs attending the symposium.

Method: Prospective questionnaire-based study.

Main Results: The majority of the delegates (79%) believed in the role of the PFM, but only 61.7% used it. Forty six percent of participants using the PFM were proficient with its use, with only a quarter knowing how to correctly compare the readings to a nomogram. There were perceived equipment shortages that may also have limited the use of the PFM in the ED.

Conclusions: The ED is a unique enviroment in which the use of a PFM mandated by the current asthma exacerbation guidelines has not been proven to be applicable. The PFM has never been shown to be of benefit to either adult or paediatric patient outcome in the ED management of acute asthma exacerbations. In this survey of healthcare practioners (HCP) in Johannesburg, the PFM was found to be an under utilised tool in the management of acute asthma exacerbations.

In light of this it is recommended that these guidelines together with the use of the PFM be reviewed by the SEPs who are managing the acute asthma exacerbations in the ED.

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NOMENCLATURE

Abbreviations

Arterial Blood Gas (ABG)

Advanced Medical Life Support (AMLS®)

Advance Paediatric Life Support (APLS®)

American College of Emergency Physicians (ACEP)

Carbon Dioxide (CO_2)

Chest X-ray (CXR)

Emergency Department (ED)

Emergency Medicine Society of South Africa (EMSSA)

Global Initiative for Asthma (GINA)

Healthcare Practitioner (HCP)

Litres per minute (L/min)

Millimetres of Mercury (mmHg)

Peak Flow Meter (PFM)

Postgraduate (PG)

Randomised Control Trial (RCT)

Short Acting $Beta_2$ Agonists (SABA)

Specialist Emergency Physician (SEP)

Venous Blood Gas (VBG)

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Chapter 1 INTRODUCTION

1.1 Motivation and rationale for this research

The idea for this research report came about as a result of an audit performed on Peak Flow Meter (PFM) use while working for a private Emergency Department (ED) management group. Despite the fact that the asthma guidelines advocate the use of the PFM, the audit revealed that the PFM was used infrequently in most asthma patients presenting to an ED with an acute exacerbation and then primarily by the senior doctors. There also appeared to be limited knowledge on how to apply he PFM readings clinically. It would appear that there is a disconnect with what is advocated and what is practised.

1.2 Aim and objectives

1.2.1 Study aim

The aim of this study was to survey and compare the perceived utility of the PFM by healthcare practitioners from both the private and public sectors attending the Emergency Medicine Society of South Africa (EMSSA) symposium with respect to asthma exacerbations in the ED.

1.2.2 Study objectives

1. To determine if the PFM was being used and if so, if it was being used correctly with regards to the assessment of severity, gauging response to

therapy and to determine appropriate and safe disposition of patients presenting to the ED with an asthma exacerbation.

2. To analyse the demographics of the study participants.

3. To determine the presence of PFMs, Peak Flow nomograms and disposable mouthpieces in the EDs where the participants worked.

4. To determine if there was a difference between the private and public sector hospitals.

Chapter 2 LITERATURE REVIEW

2.1 Introduction

Asthma is a chronic inflammatory condition affecting the lower respiratory tract, which results in paroxysmal but reversible narrowing of the affected airways. This may present with episodes of coughing, wheezing, breathlessness and chest tightness worse at night, the early morning or with exertion.(1)

Asthma is a common problem, affecting approximately 235 million people worldwide.(2) The Global Initiative for Asthma (GINA) burden report estimates a prevalence of 8.1% in the South African population.(3) It affects all ethnic groups as well as all ages, but particularly in children. In South Africa, asthma is the third most common hospital admission diagnosis in children, with the number of hospital admissions increasing over the past decade.(3) Overall case fatalities for asthma in South Africa number 18.5 per 100000 of the population, with the 5 – 34 year old age group been ranked as the fifth highest in the world.(3,4)

Asthma exacerbations are a gradual or sudden worsening of the patients symptoms requiring increasing usage of their rescue medication together with a decline in their lung functions which can be measured with lung spirometry or a PFM.(5)

Numerous published asthma guidelines exist for the assessment, stratification and discharge of asthma patients with exacerbations.(1,4–10) Other than the paediatric asthma guidelines, the remainder of the asthma guidelines reviewed for this report rely on the use of a PFM as an integral part of the management

algorithms. PFM readings are correlated with the patient's height and age, and then compared to a standardised nomogram which is used to determine the normal PFM reading for a particular patient.(11)

Despite evidence showing the benefit of adhering to the asthma guidelines, several studies, both local and international, show that healthcare practitioners (HCP) have been under-utilising PFMs in the management of asthma exacerbations.(1,4–8,12–15)

2.2 Self-monitoring for Asthma Control

The current goals for the management of asthma are set at achieving an absence of night and daytime symptoms, with no limitation of physical activity and without the need for rescue bronchodilators while maintaining a pulmonary function close to normal.(1,2)

With the above goal in mind, chronic asthma patients are being encouraged to make use of a self-monitoring plan.(1,16) The use of a self-monitoring plan is highly recommended in the management of chronic asthma in the South African guidelines.(1) The self-monitoring plans may be either based on PFM readings or recording of symptoms. Included in the PFM-based self-monitoring plan are instructions for patients to utilise a PFM on a daily basis to determine their peak flow rate. This value is then recorded in a diary kept by the patient. By performing this daily activity, patients are then able to monitor their lung function and detect any potential deteriorations before they become symptomatic. Similarly the symptom-based self-monitoring plan requires the patient to monitor their symptoms on a daily basis. When the patients experience a decline in lung

function, they are then able to vary their treatment to deal with the deterioration or if this fails, they may then visit their HCP or the ED.(17,18)

A randomised control trial (RCT) by Buist *et al* found no superiority of either the PFM-based over symptom-based self-monitoring plans.(19) Both groups demonstrated an improvement in patient outcome. However in another RCT, Gibson found the PFM-based self-monitoring plan to be superior.(16)

Not all studies have found self-monitoring plans to result in improved patient outcome and this finding is particularly prevalent in children utilising self-monitoring plans. Kamps undertook a study looking at the compliance of PFM values in children's asthma diaries.(20) By utilising PFMs containing a memory chip, he was able to compare actual values recorded by the chip to documented values in the asthma diaries. It was noted that the percentage of correct PFM values recorded in the asthma diaries dropped from 56% to less than 50% between the first and last weeks of the study. This was largely due to fabricated values being recorded in the diary. Despite been told that recording the correct values would result in a better asthma control, the children in this study became reluctant over time to use PFMs.

A Cochrane review of studies looking at the differences and effectiveness between symptom-based and PFM-based self-monitoring plans found similar results.(21) The study participants preferred a symptom-based self-monitoring plan and one of the reasons cited is that they found the performance and recording of a daily PFM reading laborious.

Overall, patients that make use of a self-monitoring plan correctly have fewer severe or life-threatening exacerbations that requires hospital presentation. Patients may also be able to provide the HCP in the ED with more information about their baseline lung function recorded in their asthma diaries.

2.3 Peak Flow Meters

History

The origin of the PFM began in 1959 when Martin Wright, a British bioengineer, described a novel instrument that had recently been developed.(22) In a small study of 20 people, he went on to present a range of normal values in healthy young adults that he validated against the pneumotachograph, an instrument that was considered the gold standard for lung spirometry at the time. The findings of the study showed that the PFM was a reliable and reproducible measurement. Wright concluded by stating that the measurements of the PFM were a "convenient and reliable way of estimating ventilator capacity".

Validation

Validation of what is now known as the Wright PFM began in the early 1990s.(23–27) By this time, there were already several different models available on the market.

In 1991, Shapiro compared the Mini-Wright and the Assess PFM with the gold standard - a calibrated pneumotachograph.(26) His results showed variability in the readings depending on the flow rate. The Assess PFM was more accurate at low flow rates while the Mini-Wright was more accurate at high flow rates. There

was also a tendency of the Mini-Wright to deteriorate after 200 uses, whereas the Assess PFM retained its accuracy.

This finding was corroborated by Gardner *et al* and Miller *et al* who also found there to be a discrepancy of the Mini-Wright PFM in the mid-flow rate range which would lead to errors in the diagnosis and management of asthma. (23,24)
However, in 1995 Pothel validated three instruments in a prospective study, the Mini-Wright, the Assess PFM and the Vitalograph. The differences between the three models of PFM were found to be negligible.(27)

In contrast to Shapiro's study, Miles *et al* studied the performance of 119 Mini-Wright PFMs to determine if there were any differences in a single instrument model.(25) There were 84 new and 35 old in total. The age of the old instruments ranged between 1 to 13 years. Only 63% of the old instruments had readings that were within 95% of the control measurements. The remainder gave values above or below the control. In addition twenty of the new PFMs were subjected to vigorous use for a year. Afterwards the instruments were retested and two were found to be under reading flow rates when compared to the 95% control. Furthermore, it was established that washing and cleaning the Mini-Wright PFM made no difference to the reported inaccuracies. He recommended that if doctors utilised patient home PFM readings, then the accuracy of readings obtained from patients PFMs should be checked.

In 1996, Tsukioka surveyed four different PFMs (Mini-Wright, Assess, Personal Best, Vitalograph) amongst the local Japanese population and found there to be

marked differences in the ranges amongst the various PFMs.(28) There was also a discrepancy in terms of the studied normal values when applied to the Japanese population.

Due to the variability in the findings of these studies, a decision was made to set standards for the measurement of peak expiratory flow.(29,30) These standards differ depending on the region of the world. The United States of America, Europe and Australia all have different standards for their peak flow meters. A trial was performed by Pesola *et al* comparing PFMs from the American Thoracic Society (ATS) and the European Union (EU) to a pneumotachometer.(31) The pneumotachometer is a form of laboratory spirometry that measures flow rates based on pressure differences across a membrane. The ATS PFM read flow rates 2.8% higher than the EU PFM. Both brands of PFM read higher values when compared to the pneumotachometer spirometer. Like Tsukioka and Shapiro, Pesola concluded that readings obtained from different brands of PFM are not interchangeable. This is particularly relevant if one is to utilise PFM readings provided by the patient as a baseline for lung function.

Regional standardisations and advancements in technology have not improved the problem of device interchangeability. In 2005, Nazir tested readings obtained from three different types of flow meters, two new devices (A; C) and one old one (B).(32) There was a significant difference amongst the three devices, including the two new devices. AC had a difference of -9.93 L/min, BC 20.08 L/min and AC 10.15 L/min. Once again, it was concluded that different PFM brands could not be used interchangeably in clinical practice.

At present, no set standards exist for the standardisation of PFM readings in South Africa. This means that different brands are available to the HCP and patient. This is not a problem as long as the HCP is aware that readings obtained from differing PFMs are not interchangeable. This variation in PFM models also plays a role in the use of a nomogram.

PFM Nomogram

A PFM nomogram is a statistical curve that represents a patient predicted PFM reading based on height, age and sex. When it was first conceived in 1973 by Nunn and Gregg it was done using normal healthy patients.(33) Since then it has been revised to include data on smokers and a wider spectrum of the population ranging from 18 – 35 years.(34,35) A separate study had to be done to determine a nomogram for the 5 – 18 age group.(36) It is worth noting that the nomograms derived in these studies were done using a Wright PFM. Nomograms are specific to the PFM from which they were derived. There are specific nomograms designed for use within the aforementioned criteria set by the EU, ATS and Australia for the readings of PFMs. For countries outside of these regions, different nomograms have had to be designed for PFMs to be used in their specific populations.(28,37) The South African guidelines for acute asthma in adults recommend the use of the Mini-Wright nomogram derived by Nunn and Gregg(Figure 2-1).(5) The paediatric guidelines make no specific recommendation because they only recommend the use of a PFM in children who are familiar with the use of the device.(4)

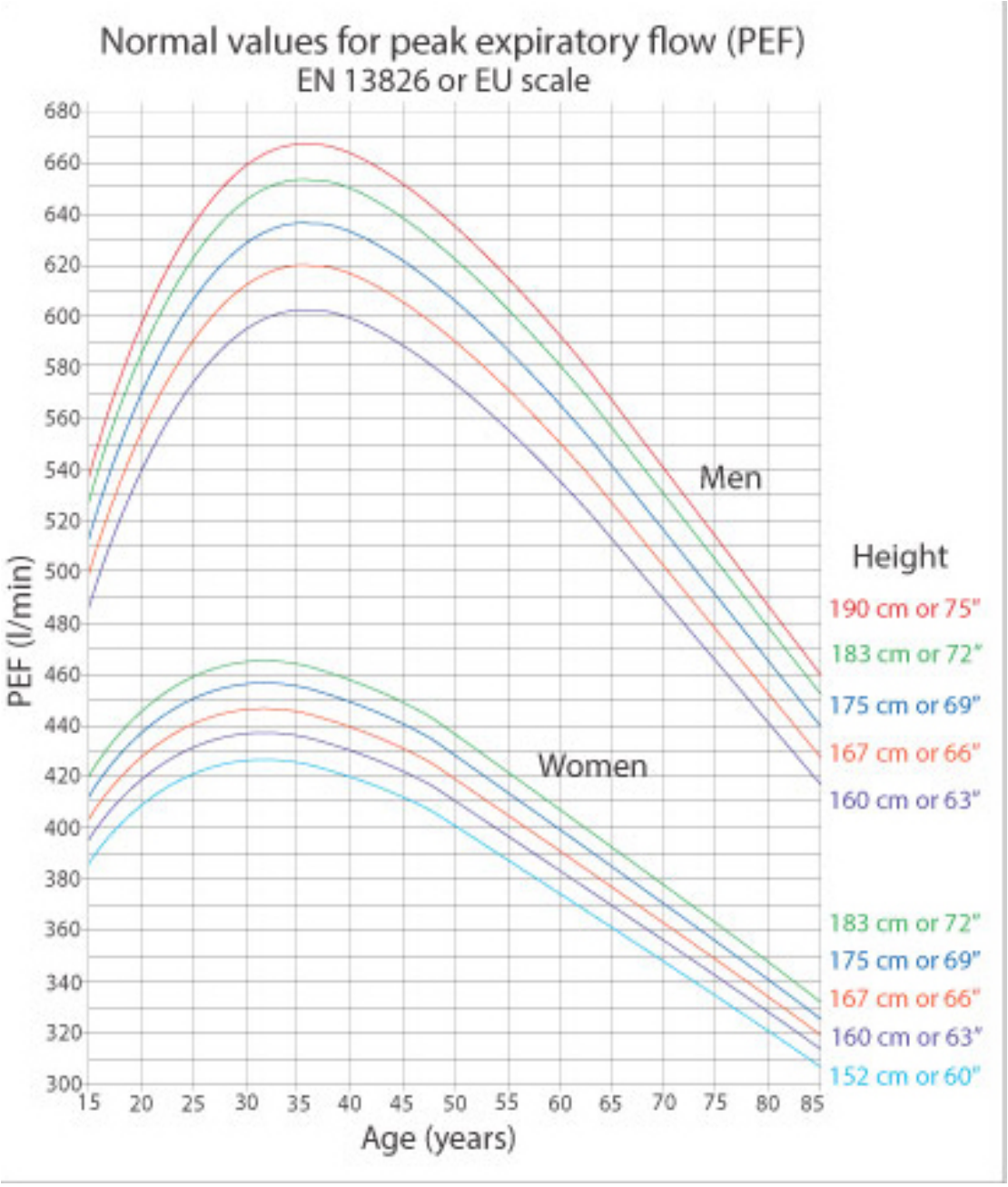

Figure 2-1: Nunn and Gregg nomogram for determining predicted PEFR.(5)

Monitoring

Monitoring of asthma plays an important role in both the daily and emergent management of the disease. The gold standard for monitoring of lung function is to use lung spirometry to measure lung function indices. The PFM is just one of the methods with which the patients lung function and response to therapy can be

objectively measured. The PFM measures the amount of air that is that is forcefully exhaled over a short time, after a maximal inhalation and is expressed as a value in litres per minute (L/min). The PFM converts the rapid flow of gas moving through the instrument into a mechanical or electronic signal that can be measured.(30)

There are presently two basic types of PFMs. The original standard range PFM is used for the measurement of lung function in older children and adults. The other PFM is the low range one designed in 1996 for the purpose of measuring smaller changes in air flow. It is limited to measurements below 400 L/min. This PFM is used in children between the ages of 4 to 9 years and adults with severe lung disease.(11)

Technique of use

Like most instruments the PFM has its advantages, but it also has a number of limitations. The PFM is an economical handheld device that does not require calibration.(30) This portability makes it very useful for the management of asthmatic patients in the ED, as it enables the HCP to easily categorise the asthmatic patient with an exacerbation, treat accordingly and determine disposition at the bedside.(6) HCPs are also able to obtain an objective measurement of the patients change in lung function in response to therapy.

The PFM is considered a simple device to use and once the correct technique of its use has been taught to patients, they are able to perform it without supervision.(11) This, however, is not the case in children, particularly under the age of five where a lack of coordination and reduced effort lead to unreliable readings.(38)

Due to the fact that there are several models of PFMs available, not all PFMs are designed to specific standards and as a result there may be variation in readings between them. This becomes a problem when the HCP is using the patient's home readings as a baseline for an exacerbation. Additionally the PFM only measures flow in the larger airways, not taking into account what is happening in the medium and smaller airways, which lead to underestimations of the patient's true lung function. As previously mentioned, use of a PFM is also very effort dependent and a poor effort by the asthmatic patient with an exacerbation may mistakenly result in an underestimation of the lung function, which can result in unnecessary treatment due to being placed in a more severe category.(11)

In order to perform a correct PFM reading the following are required:

- A PFM appropriate for the age of the patient.
- Mouthpieces for the PFM, which may be disposable or reusable.
- A nomogram.
- The correct technique
- A co-operative and willing patient.

It is essential that all HCPs that make use of a PFM in their management of asthma exacerbations be familiar with the correct technique to perform a correct peak flow. It is well-described in the South African adult asthma guidelines.(5) The patient must initially maximally inspire, followed by a maximal expiration into the PFM. This technique is obviously not applicable to all asthma exacerbation patients presenting to the ED other than those classified with mild or moderate exacerbations. The best value of three separate readings, measured in L/min

should ideally be used. This value is then used to calculate a percentage of the predicted value for that particular PFM that was used. Alternatively the value may be compared to the patient's usual baseline lung function. However there are additional variables that must be taken into account if the HCP is to use the patient's recorded baseline lung function. The patient's PFM has to have been recently checked by their regular HCP for any inaccuracies and it must be exactly the same model as the PFM used in the ED.

In reality, PFM use in the ED is of greater use in documenting a response to therapy. It is easy to understand however that a patient who is already anxious about their asthma exacerbation or as a result of excessive short acting beta agonist (SABA) use may not at that point want to perform a PFM reading.

2.4 Presentation of Asthma to the Emergency Department

Asthma presentation may be influenced by the patient's perception of dyspnoea. Asthmatics may be grouped into patients with either a blunted or a heightened response, both of which have been implicated in contributing to the excess morbidity and mortality related to asthma.(17)

Rodrigo and Rodrigo demonstrated that patients with a blunted perception tend not to realise that an exacerbation is occurring, resulting in a progressive deterioration in lung function leading to late presentations and delays in seeking medical attention.(39) This finding is corroborated by laboratory studies whereby test subjects were stimulated with metacholine and up to 20% remained asymptomatic despite dropping their lung functions to half.(40,41) This poor perception of airflow limitation places the patient at risk for the development of a

more severe form of exacerbation leading to a delay in seeking medical attention as well as a tendency for the treating doctor to not appreciate the full extent of the exacerbation. Ultimately this behaviour pattern leads to more ED visits, hospitalisations and severe asthma exacerbations.(42)

On the other end of the spectrum, patients with a heightened perception of their dyspnoea, tend to use their rescue bronchodilators excessively and as a result, increase their chance of mortality by exposing themselves to tachydysrhythmias and hypokalaemia.(43)

2.5 The Pathophysiology of Asthma Exacerbations

An asthma exacerbation is defined as a sudden or progressive increase in dyspnoea, cough, wheezing or chest tightness, that is no longer controlled by the patients medication, resulting in a consultation with a HCP.(17,44) It is further characterised by a deterioration in expiration that can be measured by lung function tests that may be used to guide management.(6)

There are two subgroups of asthma exacerbations that are based on their respective pathophysiologies(7) :-

In one subgroup, airway inflammation is the predominant feature. The gradual swelling of the airway leads to a progressive clinical and functional deterioration over a period of 6 hours to days. This subgroup occurs more prevalently in females and account for 80-90% of patients presenting to an ED with an asthma exacerbation.(45) The usual trigger is an upper respiratory tract infection. This

type of presentation is also typically associated with a slower therapeutic response. The airway histology is typified by an allergic inflammation with predominantly eosinophil cells.(39)

The other subgroup's predominant feature is a rapid onset of severe bronchospasm, which is associated with higher fatalities.(46) It occurs more prevalently in males. In contrast to the slow onset asthma exacerbation, the rapid onset subgroup is triggered by respiratory allergens, exercise and psychosocial stress. Neutrophils are the dominant cells found on histology.(39) The rapid onset subgroup responds quickly to bronchodilator therapy.(45)

2.6 Management of Asthma Exacerbations in the Emergency Department

Once the asthma patient presents to the ED with an exacerbation, they should quickly be categorised into mild, moderate, severe or life-threatening(Table 2.1).(39) Each category may initially be treated similarly with the concepts of oxygen administration, repeated SABA therapy and corticosteroids being common to all however not all categories will be adequately treated by this basic approach.(6) By determining the asthmatic patients category, the HCP is better able to monitor the patients progress in the ED in addition to escalating therapy where it is warranted.(39)

All the asthma guidelines for the management of asthma exacerbations contain similar tables showing how all the components of physical signs, PFM readings and investigations are used to categorise exacerbations.(4–8) The ED management of the exacerbation is dependent on obtaining an objective static

assessment of the severity.(39) This assessment may include limitations in speech, diaphoresis, tachypnoea, tachycardia, accessory muscle use, pulse oximetry and spirometry.(7)

Table 2.1 Classification of asthma exacerbations(5)

	Mild	Moderate	Severe	Respiratory arrest imminent
Breathless	Walking	Talking	At rest	
	Can lie down	Prefer sitting	Hunched forward	
Talks in	Sentences	Phrases	Words	
Alertness	May be agitated	Usually agitated	Usually agitated	Drowsy or confused
Respiratory rate	Increased	Increased	Often >30/min	Silent chest
Accessory muscles and suprasternal retractions	Usually not	Usually	Usually	Paradoxical thoraco-abdominal movement
Wheeze	Moderate	Loud	Usually loud	Absence of wheeze
Pulse rate (/min)	<100	100 - 120	>120	Bradycardia
Pulsus paradoxus	Absent <10 mmHg	May be present <20 mmHg	20 - 40 mmHg	Absence implies respiratory muscle fatigue
PEF after initial bronchodilator, % predicted or % personal best	>80%	Approx. 60 - 80%	<60% of predicted or personal best (<100 l/min adults) OR Response lasts <2 hours	
PaO_2 (breathing room air)	Normal	>60 mmHg (8 kPa)	<60 mmHg (8 kPa)	
	Test not usually necessary		cyanosis	
AND/OR				
$PaCO_2$	<45 mmHg (6 kPa)	<45 mmHg (6 kPa)	>45 mmHg (6 kPa)	
SaO_2 % (on room air)	>95%	91 - 95%	<90%	

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Clinical signs alone lack sensitivity when it comes to categorising asthma severity as there is considerable overlap between severity categories.(7)

Patients suffering from mild asthma are usually able to speak in sentences, those with moderate asthma in phrases and severe asthma in words or not at all.(47,48)

Study data demonstrates that over 50% of severe exacerbations will have a pulse rate of 90 – 120 beats/minute and a similar number have a respiratory rate of 20 – 30 breaths/minute, with less than 20% of severe asthmatics having a respiratory rate over 30.(7) The respiratory rate alone has a poor correlation with lung function and only indicates severe airway obstruction if it is greater than 40 breaths/minute.(49)

Accessory muscle use such as sternocleidomastoid and / or suprasternal retraction is a useful sign of airflow obstruction and correlates well with an inadequate lung function.(6)

Clinical auscultation of wheezes cannot be used at any stage of treatment to objectively grade the exacerbation.(18,39,50)

Pulse oximetry is the most commonly used clinical assessment and is particularly useful in young children and infants presenting with an exacerbation.(51) Patient oxygenation is more easily and hence preferably assessed via pulse oximetry.(39)

In the ED, the easiest method of assessing pulmonary function is with the use of a PFM. Outside of the ED, lung function tests such as spirometry are the gold standard where pulmonary function testing is concerned.(1,7)

Patients that are unable to perform a peak flow must immediately be categorised as a severe exacerbation and treated accordingly.(7,11,51,52)

The severity of the bronchospasm, its improvement or deterioration cannot be accurately assessed by reported symptoms or the physical examination alone. Serial measurements of the PFM together with the physical examination have been proven reliable to risk stratify an exacerbation and its response to therapy.(7,48,50,53)

2.7 Investigations in Acute Exacerbations

Certain investigations such as chest x-rays (CXR), arterial blood gases (ABG) or venous blood gases (VBG) may also be useful in the categorisation and management of patients with asthma exacerbations.

2.7.1 Chest X-Ray

CXRs have been shown to be of limited benefit in the treatment of acute asthma exacerbations.(54–56) In mild or moderate exacerbations they typically show lung hyperinflation. A CXR is often indicated in severe or life-threatening asthma when there is no response to therapy or if one suspects another condition such as pneumonia, pneumothorax or a pneumomediastinum.(6)

2.7.2 Arterial Blood Gas

The ABG is usually performed on patients with room saturations less than 92% or for patients not responding to therapy.(57,58) It is not indicated for all asthmatic exacerbations and is of limited value as it is generally used to determine the value

of arterial partial pressure of carbon dioxide. A normal value in an asthmatic patient with respiratory distress is indicative of hypoventilation and muscle fatigue. This is a warning sign of potential impending respiratory failure.

There are other alternatives to this painful and often difficult procedure. Clinical signs may also be used to hypothesise the carbon dioxide (CO_2) levels and muscle fatigue by looking for an obtunded patient with hypoventilation. Alternatively a PFM may be used. In 1968, McFadden described a linear relationship between the increasing levels of CO_2 and expiratory obstruction.(59) A PFM result of below 25% of normal or predicted correlates with the presence of hypercapnoea.(60) However as this result is generally associated with a scenario of a patient with life-threatening asthma it is unlikely that the HCP would be able to perform a PFM reading in this circumstance.

2.7.3 Venous Blood Gas

The VBG has recently been described in the literature as having a potential role in the assessment of asthma exacerbations. Bloom *et al*, recently (2013) investigated the correlation between venous and arterial gases.(61) This systematic review of the literature attempted to provide a correlation between arterial and venous sample values. It was established that a normal venous CO_2 correlates well with an arterial CO_2 level and excludes hypercapnoea. This means that the VBG may be used as an alternative to an ABG when assessing CO_2 levels.

2.8 Patient Disposition

The focused history, physical examination and the patients clinical course in the ED all play a role in the HCPs decision in determining how to appropriately dispose of the patient.(6)

Numerous validated studies have been done with regards to the safe disposition of the asthmatic patient with an exacerbation.(6,62–66) All of them make use of a PFM in their decision tree. The most effective in terms of time spent in the ED, was a study in 1997 by Rodrigo and Rodrigo whereby the most reliable, repeatable and efficient predictor of patient outcome was shown to be repeating PFM reading at 30 minutes post arrival in the ED.(67) Similar studies on this concept have been reported by Kelly et al in 2004, Camrago *et al* and Rodrigo himself in 2009, and more recently by Goodacre *et al* in 2013.(7,50,68,69)

Most of them come to the conclusion that during an exacerbation the patient's PFM readings, heart rate and other comorbidities were good predictors of hospitalisation.(7,68,69) The weaknesses of these studies are that the PFM readings can be influenced by other factors such as poor effort, incorrect technique or malfunctioning PFMs. Similarly the heart rate can be influenced by patient anxiety or a response to SABA use which is one of the cornerstones of treatment in an acute exacerbation.

These studies did show that reversibility of airflow obstruction in asthma exacerbations may be objectively assessed with PFM readings that have improved by >50 L/min or >40% positive change from baseline.(7) If a PFM reading is viable, these values may be incorporated into the variables that a HCP uses to

decide whether the patient may now be safely discharged or alternatively admitted for further observation and management.

As is the case in children, use of a PFM is not an absolute when dealing with the management of acute asthma exacerbations in adults. In keeping with this, the American College of Emergency Physicians (ACEP) published a policy statement in 2001 stating that there is no evidence to prove that there is a difference in patient outcome in the ED, by utilising a PFM instead of clinical signs and symptoms.(70) This policy statement was revised in 2007 with similar findings.(71)

Similarly a study in Singapore found no difference in outcome when looking at the relapse rates of patients discharged based solely on clinical improvement compared to those who utilised a PFM reading.(72) Although this was a prospective study, its numbers of 149 participants limited it.

A small study by Choi *et al* compared the PFM readings to the gold standard of formal lung spirometry of forced expiratory volume at different times of the ED presentation up to 7 days.(73) They were able to demonstrate that PFM readings underestimate the patient's true peak expiratory flow rate.

An editorial by Brusasco looked at the various evidence based benefits and deficiencies of the PFM in the ED.(74) He argued that the known inaccuracies of the PFM make it an unreliable instrument for use in the ED and until such time that the PFM be optimally validated that its recommended use be removed from the various asthma exacerbation guidelines.

2.9 Adherence to Asthma Guidelines

Despite the unproven benefit of the PFM in asthma self-management plans as well as managing acute asthma exacerbations, international and local thoracic

societies continue to advocate its use.(4–6,20,21,70,72,74–76) Furthermore, in an effort to reduce asthma morbidity, these societies are campaigning patient education particularly on how spirometry may be used in an out-of-hospital environment to pick up early deteriorations in patient's conditions prior to any exacerbations.

Despite these initiatives by the various worldwide thoracic societies, national and international studies have continued to show that spirometry is underutilised for the management of chronic asthma and its surrogate, the PFM, for the management of acute exacerbations.(13–15,77–79)

Of all the guidelines that provide evidence-based best practises for the management of acute exacerbations in the ED, only the Expert Panel Report and the British Asthma guidelines contain any contributions from specialist emergency physicians(SEP).(4–6,8–10,76)

A Canadian study looked at the use of the PFMs amongst HCPs in Canadian EDs.(13) It compared practices of SEP and non-speciality trained Emergency Physicians with regards to guideline adherence for treatment. It found a statistically significant difference of 48.1% versus 31.8% respectively with regards to PFM use.

Another potential deficit amongst HCPs is the actual knowledge on how to correctly perform a peak flow. Alrasheed *et al* did a study involving physicians and nurses based in primary health care centres in Kuwait.(80) He utilised a questionnaire to ascertain the knowledge of the study population with regards to

the use of the PFM. The results showed that physicians (66.2%) scored slightly higher than nurses (64.7%) for knowledge of steps of use. Both groups were shown to have similar but overall limited knowledge in the use of PFMs.

To address these issues, Silverman *et al* provided training for ED staff with regular feedback.(79) This resulted in a better adherence to the formal ATS guidelines.
A recent follow up study in Canada found an improvement in ED asthma care when compared to the previously published studies.(81) However, there still appeared to be a discrepancy in the study between published best practice guidelines and tertiary ED care.

2.10 Public and Private sector Emergency Departments

There are no publications available that describe the health system in South Africa. To explain the differences between the private and public sector EDs, comparisons are drawn from international literature from countries whose health systems are similar to South Africa.
In Australia, the public sector hospitals serve a much larger proportion of the population as they are based in both the rural and metropolitan areas. In contrast, the private sector hospitals are located only in the metropolitan areas where the majority of their clients of higher socioeconomic standing are located. The public sector hospitals responsibility is to ensure service delivery in rural and regional areas, while also undertaking teaching in the large metropolitan areas. The funding for public sector hospitals is provided by the Australian government whereas the private sector is funded by their clients self-funding or medical

insurance. This commissioned report by the Australian government does not discuss any similarities and differences between the EDs.(82)

A study by Wen however did compare private and public sector EDs in Singapore.(83) Similar to the Australian report, the public sector EDs service more (more than 60000) patients compared to the private sector (less than 30000). As a result, the public sector EDs were more likely to be overcapacity. In contrast this was not an issue in the private sector EDs. Although both sectors had high resources in terms of consultant doctors, the technological resources varied especially amongst the public sector.

There is a major difference between the hospitals of the Chinese health system and that of the other countries mentioned. The public sector hospitals in China have the most resources, in terms of funding, medical equipment and medical staff. A study based in China found the public sector to be superior to the private sector.(84)

The above studies only provide an insight into the differences between the public and private sector healthcare in developed countries. There is no published data comparing the two sectors in developing countries.

There is at present, a perceived difference between the public and private sector health systems in South Africa but to date, no studies have been published in this regard.

2.11 Summary

An integral part of the clinical diagnosis and management of a patient with an acute asthma exacerbation, is the predicted response to therapy. The reading of

the PFM is considered to be one of the more reliable tools available to the HCP to determine this.(6,39)

Several studies have shown that PFM evaluations in the ED have been proven to be a reliable means of assessing severity, instituting appropriate and effective management as well as ensuring the safe disposition of the patient, but few to date have been done to determine if not using a PFM results in a worse outcome.(17,50,64,69) Contrarily the ACEP found insufficient evidence to that the use of a PFM in the management of an acute asthma exacerbation was of any proven benefit and have therefore not included it in their guidelines.(70,71)

Chapter 3 MATERIALS AND METHODS

3.1 Ethics

This research was approved by the Human Research Ethics Committee of the Faculty of Health Sciences of the University of the Witwatersrand (protocol approval number M121025 – Appendix 1). Informed consent for the participant was deemed unnecessary by the Ethics Committee as they assessed that completing the questionnaire was done on a voluntary basis.

Consent was also obtained from EMSSA to conduct the research at their symposium.(Appendix 2)

3.2 Study Design

The project was a questionnaire-based cross-sectional study.

EMSSA convene a congress every alternate year while a symposium is arranged in between. This study was hosted over a weekend at the Johannesburg symposium in November 2012. The symposium attendees consisted of medical, nursing and prehospital practitioners.

The questionnaires were provided to the EMSSA organising committee prior to the start of the symposium, who placed a copy in every conference bag supplied to the attendees. A short statement was made at the opening address, whereby attendees were advised of the study.

An information brochure explaining the purpose of the study as well as the consent provided by the Ethics and the EMSSA research committees was attached to the front of each questionnaire.(Appendix 3) The questionnaire was then completed by the study participants.(Appendix 4)

The participants were encouraged to answer honestly by ensuring their anonymity.

3.3 Study Setting and Population

Attendees of the Johannesburg EMSSA Symposium in November 2012 were invited to participate in the completion of a voluntary questionnaire.

The specific population surveyed were HCPs, consisting of nursing and medical practitioners.

Inclusion criteria:

Medical and nursing practitioners. This included all emergency medicine registrars, SEPs and general practitioners working in the various EDs.

Exclusion criteria:

Paramedics attending the symposium were excluded.

3.4 Study Protocol

3.4.1 Data collection

Data was collected by the researcher in the form of an anonymous questionnaire completed by the participant.

- The questionnaires were enclosed in the conference bags provided to all the attendees at registration at the beginning of the symposium.
- All the study participants were encouraged to read the information brochure, which also assured them of their anonymity, before answering the questionnaire.
- Participants were allowed to fill in the questionnaire at their own pace and location of choice over the course of the two days.
- Completed forms were dropped into five clearly marked collection boxes. A box was placed outside the entrance to each seminar room as well as at the main exit.
- The completed forms were collected from the boxes at the end of each day of the weekend symposium.
- A group of participants did complete the questionnaires in their own time and gathered all of the documents into an envelope marked as Private and confidential. The researcher was then contacted telephonically and asked to collect the envelope.

Questionnaire expansion

Qualifications were grouped as follows:

- Bachelor Degree
- Bachelor Degree with Postgraduate diplomas
- Fellowships
- Masters or Doctorate degree

If the participants listed any attendance courses that they may have completed, these were not considered to qualify as formal postgraduate training, and not

recorded for statistical purposes. The following attendance courses were excluded:

- Basic Life Support®
- Basic Emergency Skills Training®
- Airway Management in Emergencies®
- Advanced Cardiac Life Support®
- Paediatric Advanced Life Support®
- Advanced Medical Life Support®
- Advanced Trauma Life Support®

Postgraduate diplomas consisted of any qualification that may have been obtained by the participant subsequent to their primary degree. The diplomas noted were:

- Diploma in Trauma Nursing
- Diploma in Critical Care Nursing
- Diploma in Primary Emergency Care
- Diploma in Anaesthetics

The question regarding the role of the PFM was used to split the participants into two, those that thought the PFM played a role in the management of acute exacerbations and those that did not.

The question on correct use of the PFM was only posed to the subgroup of participants who believed in the role of the PFM.

Participants were asked to mark in order of sequence, the most correct statements for performing a correct PFM reading.

Table 3.1: Marking Schedule of Peak Flow Meter use

Correct statement and sequence	10
Correct statement, incorrect sequence	8
1 incorrect statement	6
2 incorrect statements	4
3 incorrect statements	2
No understanding	0

3.4.2 Outcome Measures

Participants were asked to provide data for the purposes of demographics. This information was used to categorise participants in terms of profession, postgraduate training and years of clinical experience.

A clinical scenario section asked participants to rate themselves in their usage or non-usage of the PFM with regards to assessment of severity, gauging response to therapy and appropriate disposition of the patient.

Additionally, a clinical knowledge section was included into the questionnaire in the event that there were no PFM available in the ED that the participant was working in. This established the practical and appropriate use of a PFM in order to establish the healthcare professional's competency in the use of a PFM.

3.4.3 Sample Size Estimation

Equation 1: Sample size Equation

$$p \pm 1.96 * \sqrt{p\,(1-p)/n}$$

p: Population of medical and nursing practitioners, attending the congress that qualify for the study.

n: Sample Size required

p: 114

n: 65

Confidence interval: 8

Confidence level: 95%

3.4.4 Data Analysis

Data was entered onto a Microsoft Excel® (Microsoft Office 2007, Microsoft Corporation) which was then used for the statistical analysis.

The analysis was descriptive, making use of means and percentages.

All data analysis was carried out in SAS.(85)

3.4.5 Methods of analysis

Pearson's χ^2 test was used to assess for significant relationships between categorical variables. Fisher's exact test was used for 2 x 2 tables or where the requirements for Pearson's χ^2 test could not be met. The strength of the associations was measured by Cramer's V and the phi coefficient respectively.

For Cramer's V and the phi coefficient, the following scale of interpretation was used:

0.50 and above	high/strong association
0.30 to 0.49	moderate association
0.10 to 0.29	weak association
Below 0.10	little if any association

The Wilcoxon rank sum test was used to assess the relationship between categorical and continuous variables, since the assumptions for the two-sample t-test were not met.

3.4.6 Significance level

A P-value <0.05 was considered to be significant for all statistical tests. The 95% confidence level was used throughout, unless specified otherwise.

Chapter 4 RESULTS

4.1 Sample size and Response rate

There were 114 attendees at the Symposium who were eligible to complete the survey. Of these, 73 participants completed the survey. The response rate was 64%.

4.2 Descriptive Information

All participants answered these questions (n=73).

4.2.1 Workplace location

The majority of participants worked in Gauteng.

Table 4.1: Workplace Location

Origin	Actual Number	Percent
Gauteng	67	91.8
Northwest	2	2.7
Kwazulu Natal	2	2.7
Limpopo	1	1.4
Lesotho	1	1.4
Total	73	100

4.2.2 Primary place of work

Table 4.2 Emergency Department description

ED	Actual number	Percent
Private Sector	25	34.3
Public: Primary	0	0.0
Public: Secondary	6	8.2
Public: Tertiary	29	39.7
Public: Quaternary	13	17.8
Total	73	100

.

For further analysis, public and private EDs were grouped. Thus, 65.8% of the participants worked primarily in the public sector while the remainder worked primarily in the private sector.

4.2.3 Healthcare Practitioner category

The majority (72.6%) of the participants were medical doctors while nursing staff made up the remainder.

4.2.4 Postgraduate qualifications

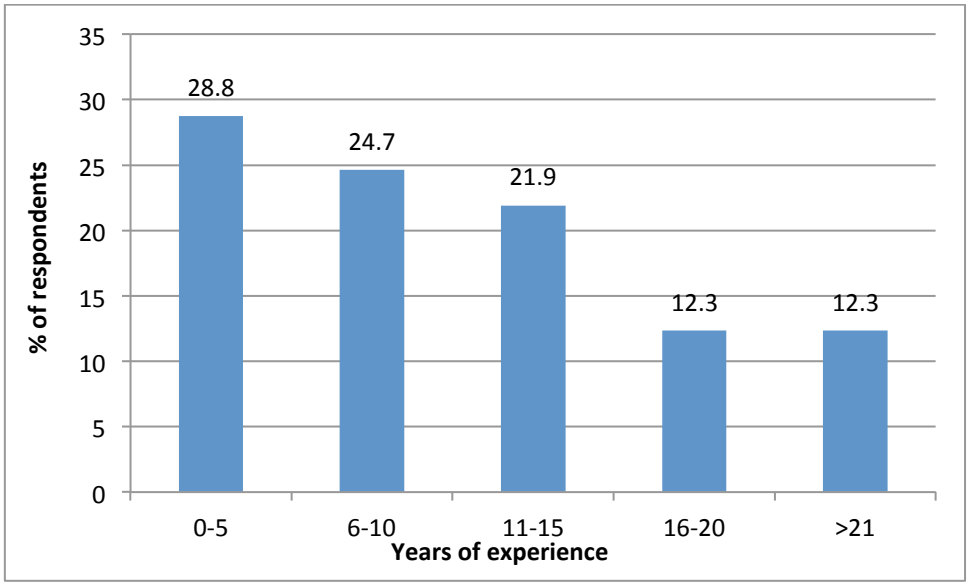
Table 4.3: Postgraduate Qualifications

Qualification	Actual number	Percent
No postgraduate qualifications	40	54.7
Bachelor Degree + PG Diploma	7	9.5
Fellowship	10	13.7
Masters	1	1.4
Emergency medicine registrars	10	13.7
No response	5	6.9
Total	73	100

Amongst the participants with fellowships, were one respondent from Family Medicine, one from Paediatrics and eight from Emergency Medicine.

4.2.5 Years of experience since graduation

Table 4.4: Years of Experience



4.3 The PFM

4.3.1 Role of the PFM in acute exacerbations

Table 4.5: Establishing the role of the Peak Flow Meter

Category HCP		PFM role		
		NO No.(%)	YES No.(%)	TOTAL No.(%)
Medical	Actual number	7 (13.2)	46 (86.8)	53 (100)
Nursing	Actual number	8 (40)	12 (60)	20 (100)
Total		15	58	73

There was a significant, moderate, association between whether or not respondents felt that the PFM plays a role in the ED and HCP category (p=0.021). Medical professionals were more likely to be of the opinion that the PFM plays a role compared to nursing professionals.

There was no significant association between whether or not participants felt that the PFM played a role in the ED with postgraduate qualification status (p=0.77) or years of experience (p=0.67).

4.3.2 Do you use the PFM?

Table 4.6: Use of the PFM in the subgroup that believed in its role

PFM use	Number	Percent
NO	13	22.4
YES	45	77.6

There was no significant association between this question and HCP category (p=0.44) or ED type (p=0.53).

4.3.3 Availability and use of PFM, nomograms and disposable mouthpieces

Table 4.7: The proportion of participants who reported that PFMs / nomograms / disposable mouthpieces available in the ED

Variable	Category	PFM plays a role (n=58)						p-value for association between variable and ED type
		Overall (n=58)		Private ED (n=23)		Public ED (n=35)		
		n	%	n	%	n	%	
Adult PFM in ED	Yes	45	77.6	21	91.3	24	68.6	0.043
	No	11	19.0	1	4.3	10	28.6	
	Don't know	2	3.4	1	4.3	1	2.9	
Adult PFM chart in ED	Yes	30	51.7	14	60.9	16	45.7	0.62
	No	25	43.1	8	34.8	17	48.6	
	Don't know	3	5.2	1	4.3	2	5.7	
Paed PFM in ED	Yes	17	29.3	13	56.5	4	11.4	0.0010
	No	34	58.6	8	34.8	26	74.3	
	Don't know	6	10.3	2	8.7	4	11.4	
Paed PFM chart in ED	Yes	15	25.9	11	47.8	4	11.4	0.0062
	No	35	60.3	9	39.1	26	74.3	
	Don't know	7	12.1	3	13.0	4	11.4	
Disposable mouthpieces in ED	Yes	32	55.2	21	91.3	11	31.4	<0.001
	No	20	34.5	0	0.0	20	57.1	
	Don't know	6	10.3	2	8.7	4	11.4	

The availability of disposable mouthpieces had a strong association with ED type (p<0.0001).

4.3.4 What patient-specific information do you think is required to make a correct PFM reading?

Table 4.8: Patient-specific information required to make a correct reading

Respondents No.(%)	14 (24.6)	8 (14)	3 (5.3)	1 (1.8)	1 (1.8)	1 (1.8)	1 (1.8)	1 (1.8)	4 (7)	5 (8.8)	18 (31.6)
Height	Y						Y	Y	Y	Y	Y
Weight				Y	Y	Y				Y	Y
Age	Y	Y	Y			Y		Y			Y
Gender	Y		Y		Y	Y			Y	Y	Y

There was no significant association (p=0.26) between whether or not participants had answered the question correctly and ED type.

4.3.5 Correct use of the PFM

Table 4.9: PFM use scores

PFM SCORE	**Number No. (%)**
0	2 (3.8)
2	1 (1.9)
4	3 (5.7)
6	13 (24.5)
8	10 (18.9)
10	24 (45.3)

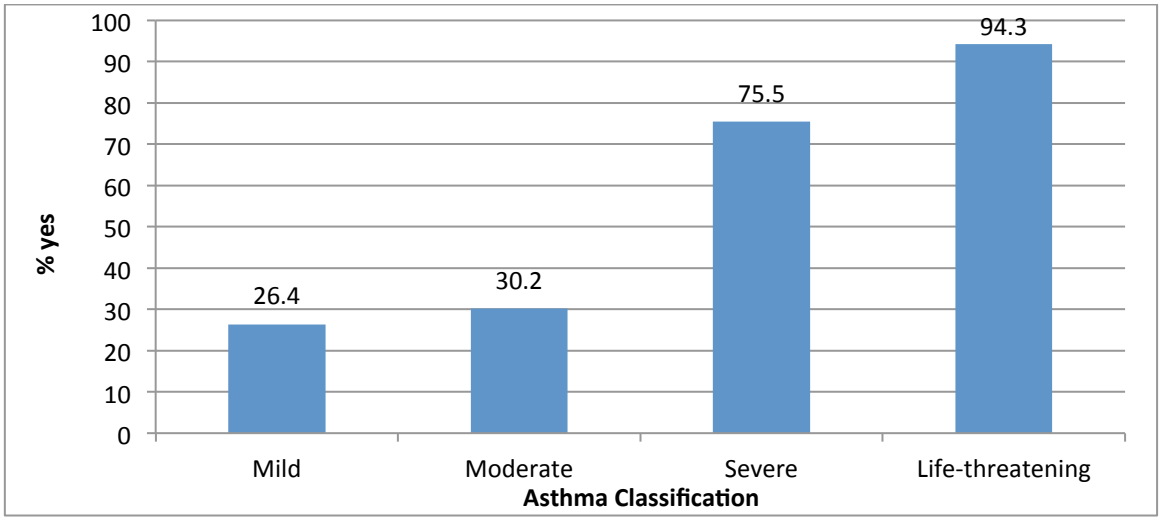
(Five respondents did not answer the question)

Scores of 8 or 10, were assessed as having an acceptable level of knowledge.

4.4 PFM use in acute exacerbations

4.4.1 Circumstances under which PFM would be used to classify patients according to their presenting severity

Table 4.10: In which cases would the peak flow meter be used?



4.4.2 Circumstances of initiation of therapy without the use of a PFM

Table 4.11: Overall percentage of participants who would initiate therapy without the use of the PFM

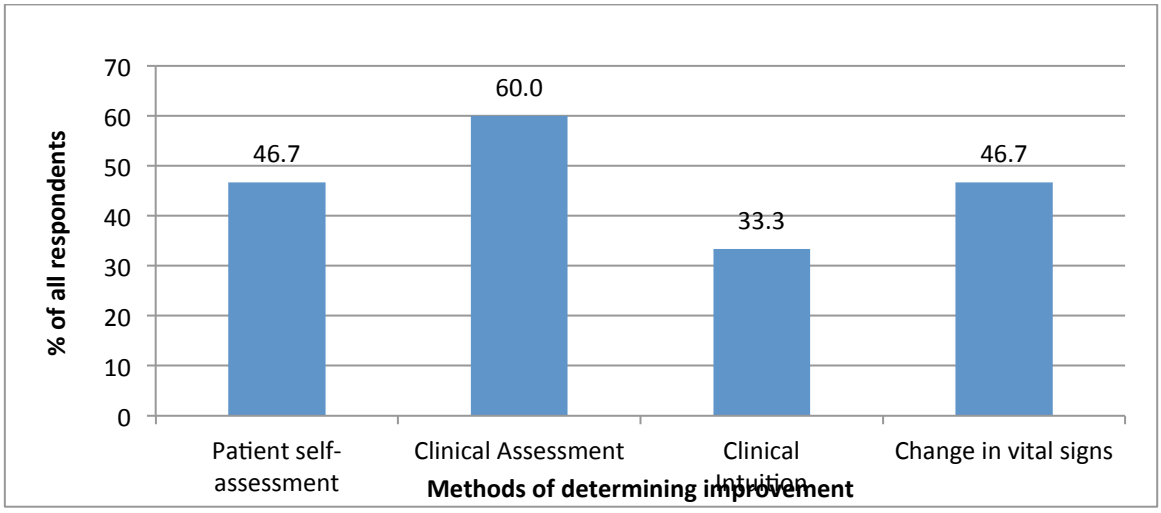
	% YES
Mild	26.4
Moderate	30.2
Severe	75.5
Life-threatening	94.3

4.5 Patient reassessment

4.5.1 Information used to determine therapeutic response to initial treatment

4.5.1.1 No role for PFM

Table 4.12: Methods to determine improvement without the PFM – Overall Percentages



(Participants were allowed to choose more than one answer)

4.5.1.2 PFM role

Table 4.13: Method of reassessment amongst participants who thought PFM had a role

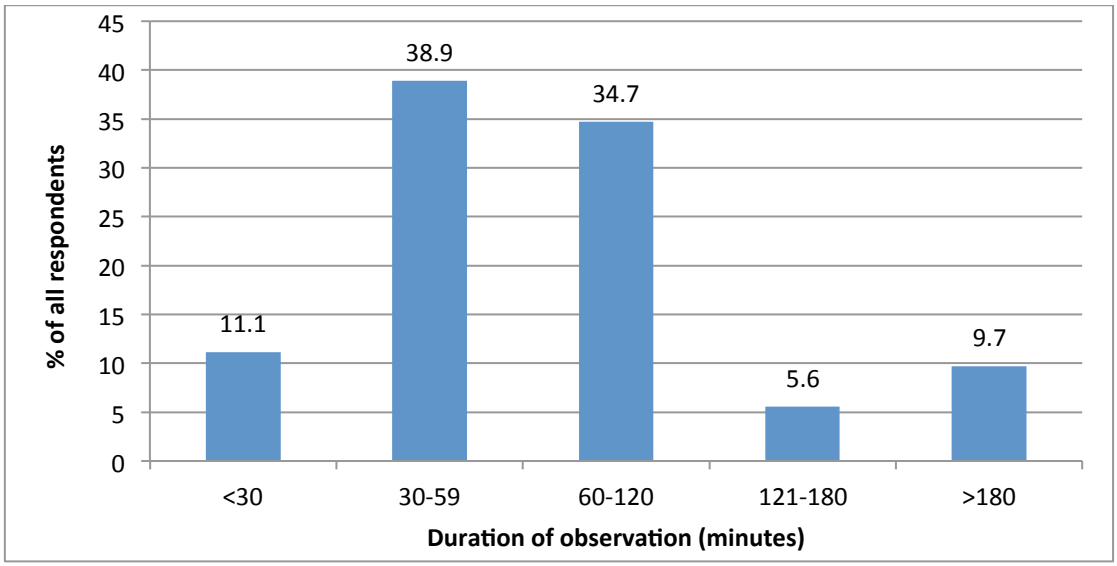
Patient reassessment	Frequency	Percent
Both PFM & clinical	51	89.5
Clinical assessment	6	10.5

No participants reported that they would rely on the change in PFM reading alone.

4.5 Safe patient disposition

4.6.1 Duration of observation before decision regarding disposition

Table 4.14: Time of observation



(One respondent did not answer the question)

4.6.2 Factors determining disposition

Table 4.15: Factors determining disposition

Variable	Category	PFM role		
		Overall (n=73) No. (%)	NO (n=15) No. (%)	YES (n=58) No. (%)
Patient self-assessment	NO	51(69.9)	8(53.3)	43(74.1)
	YES	22(30.1)	7(46.7)	15(25.9)
Patient wants to stay / go home	NO	64(87.7)	14(93.3)	50(87.7)
	YES	8(11)	1(6.7)	7(12.3)
	UNANSWERED	1(1.4)		
Clinical Intuition	NO	35(48)	9(60)	26(44.8)
	YES	38(52.1)	6(40)	32(55.2)
Change in PF readings (PFM role=YES: n=58)	NO	19(32.8)	-	19(32.8)
	YES	39(67.2)	-	39(67.2)
Improvement in vital signs (PFM role=NO: n=15)	NO	7(46.7)	7(46.7)	-
	YES	8(53.3)	8(53.3)	-
Response to therapy	NO	9(12.3)	3(20)	6(10.3)
	YES	64(87.7)	12(80)	52(89.7)

(Participants were able to choose more than one predetermined answer to this question).

Chapter 5 DISCUSSION

5.1 Introduction

The pivotal step in the ED management of acute asthma exacerbations is assessing the response to instituted therapy. This ultimately determines the patients disposition as well as the possible escalation of further therapy. Many ways exist for the physician to determine this response, however the PFM provides an objective, repeatable method of assessing the reversibility of airflow limitation.(6,39) The discrepancy between guideline suggestion and actual utilisation by HCP working in the ED was investigated.

5.2 Response rate

There was a response rate of 64%. Comparatively, a local study by Vallabh *et al* which looked at the perceptions of knowledge and use of PFMs had a response rate of 92%.(77) The only questionnaire based studies on PFM usage done internationally were by Grunfeld and McDermott who had response rates of 60.1% and 71.9% respectively.(13,14)

The response rate of this study was similar to those performed internationally, but differed greatly to the local study by Vallabh. This discrepancy could have been as a result of the differing study populations examined.

Participants who were not fluent in English may have been reluctant to complete the questionnaire as no pilot study was done and as a result any ambiguity or difficult questions may have been overlooked.

By selecting the EMSSA symposium for the purposes of data collection, the participants were exposed to an unforeseen limitation of time. The information sheet declared that the questionnaire would take approximately 20 minutes to

complete. Unfortunately the period between lectures at the symposium varied between 5 to 15 minutes which may have biased the responses towards the end of the questionnaire or limiting the participant's ability to complete it in one sitting thus making it easier not to complete. Additionally the data collection period was time limited to the duration of the symposium. There was also no possibility of a follow up survey to be done to participants who did not respond in the initial survey. The other questionnaire-based studies were not limited in this way.

Although the questionnaires could be taken home, only 4 participants contacted the researcher to collect the completed questionnaires after the end of the symposium. None of the participants made use of e-mail or facsimile options of returning questionnaires.

The subjective nature of this questionnaire may also have allowed for the possibility of potential bias to occur. Participants were required to declare, albeit anonymously their use or no-use of a PFM. They may have exaggerated their use of a PFM, in order to appear compliant with published guidelines.

5.3 Descriptive

Workplace Location

Sixty seven percent of the participants worked in the Gauteng province. The remainder were from the Kwazulu Natal, Limpopo and Northwest provinces. One delegate was from outside of South Africa. Vallabh *et al* limited his survey to the Lenasia and Soweto regions of Johannesburg.(77) The majority of participants in this study were from Gauteng probably due to the fact that the symposium was held in the province.

Primary place of work

Most of the participants worked primarily in the public sector(66%). They represented secondary, tertiary and quaternary hospitals. Nobody from the public sector primary clinics that may have attended the symposium chose to participate in the study. The private sector made up the remainder of the participants. This differed to the local study by Vallabh *et al* in which he actively recruited participants of which 43% were from the public sector.(77) The studies by Grunfeld and McDermott that were performed in Canada and Chicago made no mention in their studies of any division between the public and private sectors.(13,14) The proportions of participants in this study were completely unplanned.

HCP category

Medical doctors made up 73% of the participants. Alrasheed also used both medical doctors and nursing staff as part of the study sample but it was limited to primary health care clinics in Kuwait.(80) Vallabh only included medical doctors in his study of PFM use, as did the studies based in Canada and Chicago.(13,14,77) This study appears to be the only one in the reviewed literature that included both medical doctors and nursing staff in the study sample with regards to PFM use in the ED.

PG qualification

Seven of the participants had some form of postgraduate training in the form of diplomas in emergency medicine, anaesthesia, critical care or trauma nursing. Ten emergency medicine registrars participated in the study. Ten participants had a fellowship qualification with eight of these being SEP. The remaining two were

specialists from paediatrics and family medicine. Thirty-seven participants had no formal postgraduate training. This comprised general practitioners and nursing staff. These overall numbers contrast with the international studies by McDermott and Grunfeld that were made up entirely of SEP.(13,14) The studies by Vallabh and Lum were restricted to general practitioners.(77,78) Compared to this study, the North American studies had larger numbers of participant SEPs. This is because emergency medicine is by comparison a new specialty in South Africa having only been registered in 2005.(86) Therefore, it is not unexpected to find smaller amounts of SEP participants in this study population.

Years of Experience

Twenty-nine percent of the participants had less than 5 years of experience in clinical experience. The numbers decreased as the years of experience increased. This finding may also be explained by the fact that the emergency medicine specialty in South Africa is still in its formative years.

5.4 The Peak Flow Meter

PFM in ED exacerbation management?

Participants were grouped into two groups depending on their answer as to whether they made use of a PFM in their management of acute asthma exacerbations. Fifty-eight of the study participants felt the PFM plays a role in their management of asthma exacerbations. Forty-six of these were medical doctors and the remainder were nursing sisters. The subgroup that did not believe in the role of the PFM was made up of 7 doctors and 8 nurses. These findings were not

influenced by other factors such as ED type, years of clinical experience or postgraduate qualifications. It may be hypothesised that a lesser amount of nursing sisters make use of the PFM due to a lack of awareness of its potential role in the management of acute asthma exacerbations. This may be further influenced by other factors such as its use not being emphasised in their training or due to a shortage of equipment in the respective EDs thus limiting its use. There is no data to compare these findings because as it was previously mentioned, this study is the only one comparing medical doctors and nursing staff use of the PFM in the management of asthma exacerbations in the ED.

Do you use the PFM?

The majority of the 58 participants believing in the role of the PFM, made use of it in their management of asthma exacerbations. This means that overall 28 of the study participants either did not believe in the role of the PFM or make use of it. The use of the PFM was not influenced by ED type, postgraduate qualification status or years of experience. This finding is higher than the figures obtained by Grunfeld where he found that 10.9% of Canadian SEPs never made use of a PFM while 15.8% occasionally used it.(13) Similarly McDermott obtained figures of 22.2% of non-use amongst Chicago-based EDs.(14) Locally Vallabh found that 79% of general practitioners never made use of the PFM in their daily practice.(77) Vallabh's study was limited to the practices of family practitioners and primary health care clinics. The participants of Vallabh's study may also have been limited by the acuity of the exacerbations they were exposed to while working in primary health care clinics. This study was performed on HCPs working in an ED, where

asthma exacerbations are more likely to be encountered, making it more likely that a PFM would be used.

Availability of peak flow meters, nomograms and disposable mouthpieces in the ED

Most of the participants (77%) that believed in the role of the PFM indicated that their ED had an adult PFM, but only 52% had access to a nomogram or disposable mouthpieces (55%). Less than a third (28.8%) of participants stated that they had access to all three. This brings into question whether the remaining participants have the equipment to effectively use the PFM due to these perceived deficiencies or if an alternative method of PFM use is being utilised such as percentage improvement.(7)

The majority of participants from private sector EDs indicated that they had an adult PFM compared to 69% in the public sector. Twenty-nine percent of participants from the public sector indicated that there was not an adult PFM in the departments they worked in compared to 4% from the private sector. An equal number of single participants from both the public and private did not know if their respective EDs had adult PFMs. There appears to be a wide difference in the availability of adult PFMs in the EDs in which the participants worked. However, neither the Australian study looking at differences between the private and public healthcare sectors nor the study by Wen which looked at differences between public and private sector EDs in Singapore reported any deficiency of equipment in the public sectors.(82,83) In fact, Eggleston's study in China proved that the public sector was superior to the private sector.(84) There are no studies in South

Africa looking at any differences between the private and public sectors. Additionally, no conclusions can be drawn about any perceived deficiencies of equipment in the public sector based solely on the replies of ten participants concerning the EDs in which they work. The study sample is too small to be considered representative of the entire public health sector.

Only 52% of the participants indicated the presence of a nomogram in their EDs. This was fairly evenly split in terms of numbers amongst the private sector and in the public sector. This study did not address if the nomograms present in the respective EDs were appropriate for the adult PFM used. As seen in the studies by Tsukioka and Deng, nomograms are designed for specific populations as well as PFM and are not interchangeable.(28,37)

Less than a third (29%) of the total study participants indicated that their ED had a paediatric PFM. Fifty-seven percent of participants from the private sector indicated that they had a paediatric PFM compared to 11% of the public sector. Although the numbers of participants from each ED were small, the wide difference between the two ED types is possibly due to the fact that the private sector EDs treat both adult and paediatric patients, whereas the public sector EDs typically allocate the treatment of these patients to two separate departments which separately take care of either paediatric or adult patients. The studies from Australia, China and Singapore did not indicate if there was such a division in their public sector EDs.(82–84) This does not however explain why the numbers of paediatric PFMs (n=11) differ to such an extent from the adult PFMs (n=21). If both categories of patients are treated in the private sector, one would expect the

number of paediatric PFMs to be equal to the adult PFMs. From another viewpoint, participants from the private sector EDs that reported an absence of paediatric PFMs (n=8) may not have treated any paediatric asthma exacerbations and therefore be unaware of their presence. Alternatively the absence of paediatric PFMs could be attributed to their higher cost. These possible scenarios emphasise the fact that the numbers displayed here are based on perceptions of the participants and not based on an actual audit of that respective ED. Paediatric patients have been shown to have difficulty in obtaining correct PFM readings if they are under the age of 5 or are unfamiliar with the use of a PFM.(38) In the same study, Gorelick *et al* were also able to demonstrate the unreliability of PFM readings under the age of 10.(38) Eid *et al* also found the use of paediatric PFM readings to be unreliable as they were associated with false negative results.(63) A survey of paediatric ED physicians found that less than two thirds make use of a paediatric PFM in the treatment of asthma exacerbations.(12) The use of a paediatric PFM is only a recommendation in the South African paediatric guidelines if the patient is familiar with its use.(4) All of this would imply that it is not only acceptable but also possible to treat a paediatric asthma exacerbation without a PFM. Therefore it is reasonable to assume that if paediatric asthma exacerbations are being treated without PFMs, that the study participants may not have been aware if the equipment is actually available for use. Therefore no conclusions can be reached with regards to these perceived deficiencies in paediatric PFMs.

Almost half (48%) of participants from private sector EDs reported that they had paediatric nomograms available to them compared to 11% of the public sector

EDs. The difference in numbers between the private and public sector may once again be due to their respective differing patient profiles discussed earlier. There was an equal amount of nomograms (n=4) for PFMs (n=4) reported by the public sector participants. The private sector had 11 nomograms for 13 paediatric PFMs. Once again, these numbers are based on the participant's perceptions of equipment available in their respective EDs, which may not correlate with numbers from a formal audit.

Thirty-one percent of the public sector HCPs stated that there were disposable mouthpieces in the EDs in which they worked. This differed from the 91% reported by the participants of the private sector. Once again, this is a perceived shortage by twenty participants from the public sector and cannot be considered representative of the entire public heath sector. Additionally the questionnaire did not make any distinctions between the use of disposable or reusable mouthpieces. The reported numbers of disposable mouthpieces may also be low, if that particular ED washed and sterilised the components before reusing them.

The limitations of this study prohibit speculation on the availability of PFMs, nomograms and disposable mouthpieces in the respective EDs. However there appears to be a perception amongst the public sector participants that there is a shortage of equipment that is required to use the PFM to its full effect. The results showed a significant association between the public sector EDs and the presence of disposable mouthpieces. Also the private sector participants perceive there to be a lesser number of paediatric PFMs compared to the adult PFMs available. Since paediatric patients may also be treated effectively without the use of a PFM,

the participants may simply not be aware of the presence of PFMs. Due to the small numbers of this study, these findings cannot be assumed to be representative of the entire public and private health sectors.

Patient specific information

In order to establish whether the participants that made use of the PFM did so correctly, participants were asked to identify what patient specific information would be required to make a correct reading.(35)

Twenty-five percent of the participants were able to correctly identify the correct requirements of height, age and gender and exclude weight as an incorrect answer. This response had no association of whether the participants were from the private or public sector EDs. Thirty-two percent chose all the possibilities, including weight. The remaining 43% chose one or more of the provided answers. Twenty-six of the 58 (44.8%) participants in the subgroup incorrectly identified weight as a patient specific variable.

Explanations on how to use a PFM reading in conjunction with an appropriate nomogram are included in the GINA guidelines as well as the joint ATS and European Respiratory Society statement.(6,76) The South African 2013 asthma guidelines by Lalloo *et al* also provide an explanation on the correct use of a PFM.(5) This study did not address whether the 75% of this subgroup were not correlating the PFM readings with a nomogram due to a lack of knowledge or if they were utilising the PFM readings differently. For instance, it is not necessary for one to correlate the PFM readings to a nomogram if one is just using it to demonstrate a response to therapy, ie. percentage change. There are no studies

available which compares the various methods of using a PFM in the management of an acute asthma exacerbation in the ED.

Correct use of a PFM

The mean score obtained by the participants was 8 out of a possible 10. Twenty-four (45.3%) participants of the subgroup that made use of the PFM were able to identify the correct sequence of events for performing a PFM reading. Ten participants (18.9%) chose the correct statements but placed them in an incorrect order. Seventeen participants made between 1 and 3 errors. Two participants (3.8%) had no understanding of how to perform a PFM reading. There was no difference in the total score obtained when comparing HCPs or ED type.

The participants of Doerschug's study scored 60% in their assessments of PFM use.(87) However this study was done on a different study population in a different setting. It was performed in the University of Iowa on members and residents of the General Medicine and Family Medicine faculties. It looked at various aspects of the PFM, of which correctly describing how to perform a peak flow was just a portion of the research.

An analysis of the correct use of the PFM by the participants was made by asking them to identify the steps of utilising a PFM. The reviewed literature that evaluated correct PFM use in a questionnaire format did not detail their method of assessment in the publications, hence no validated assessments were available to be reproduced in this study.(77,80,87,89) Consequently the assessment method derived and used in this study had to be designed and was never validated. Additionally by being at the very end of the questionnaire, participants may not have given this question an appropriate amount of time or thought.

The participants in the study by Hajia *et al* scored 39% in their assessment of PFM use, however the study sample consisted of nursing staff based in primary health care clinics in Kuwait.(89) Alrasheed also took his study sample from primary health care clinics in Kuwait, but his study looked at both medical doctors and nursing staff.(80) They scored 50% on their assessment of PFM use. Although Alrasheed was able to demonstrate a small difference in scores between doctors (66%) and nurses (64%), this study did not find any significant difference (p=0.70) between the scores for category of HCP.

The general practitioners based in the community health clinics in Soweto and private practises in Lenasia, studied by Vallabh scored 33% on their assessment on the use of the PFM.(77) The PFM use assessment score of 46% obtained by the participants of this study was similar to the studies in Kuwait, but higher than the scores obtained by Vallabh.(77,80,89) The differences in training and experience between general practitioners and SEPs may account for these findings.

Overall, 46% of the study participants were able to describe the correct use of a PFM, however only 25% were aware of how to correlate the readings obtained with an appropriate nomogram. Although this may be the prescribed method, the uncorrelated PFM readings may alternatively be used to determine a response to therapy by demonstrating a percentage change.

Are peak flow meters being used to gauge severity?

When patients with acute exacerbations present to the ED, they are quickly assessed to determine their severity by being classified into a mild, moderate,

severe or life-threatening category. The patient's severity determines the treatment administered. This classification is based on a number of factors including vital signs, clinical assessment and a static assessment such as spirometry. The clinical assessment and the patient's vital signs are an indispensible part of managing the acute asthmatic exacerbation in the ED. The use of spirometry however has never been proven to affect a patient's clinical outcome in the ED.(70,74)

In order to determine whether PFMs were being used to gauge severity, participants were asked a series of questions to establish their clinical practises. When asked under which circumstances they would use a PFM to gauge the severity of asthma exacerbations, 81% and 95% of the participants stated that they would use a PFM to assess mild and moderate cases respectively. Less than half (48%) would use the PFM in severe cases while only 19% stated they would use them in life-threatening cases. When one looks at the literature arguing both for and against the use of the PFM in the management of asthma exacerbations, both parties are in agreement that a PFM is unreliable in severe and life-threatening cases.(7,38,39,47–49,70,72,74) In these circumstances it is both logical and intuitive that the HCP would treat the patient first rather than try to obtain a reading that has been shown to be unreliable in these situations.(38,66,69) Yet the asthma guidelines continue to make the PFM reading a part of the classification for severe and life-threatening exacerbations.(4–6,8,76,87) In a contradictory statement, GINA, as well as the recent South African guidelines advocated that a PFM not be used in cases of life-threatening asthma.

(5,6) These inconsistencies make it difficult for the HCP to decide on what is the correct course of action.

Initiation of therapy without a PFM

Participants were asked under which circumstances they would initiate therapy without the use of a PFM reading. However these results do not appear to correlate with the findings of the previous question resulting in the following discrepancies. The majority (94%) of participants would initiate therapy in life-threatening exacerbations yet 19% reported that they would use a PFM in the same life-threatening cases. Similarly, 76% of participants would initiate therapy in severe exacerbations, but 48% would use the PFM in the same circumstances. A third (30%) initiate therapy in moderate cases and yet 95% stated that they would use a PFM first. Although 81% claimed to use a PFM in mild exacerbations, only 26% of the subgroup would initiate therapy without it. McDermott's study reported that 77% of the participants would use a PFM reading as part of the initial assessment.(14) However, McDermott makes no distinction under what circumstances it would be used despite reporting a wide degree of variability. Grunfeld reported a similar (74%) result, but also did not break it down with regards to the acuity of exacerbation.(13) The South African study reported that the PFM would be used to assess severity in 58% of all scenarios.(77) It is not possible to make any comparisons of the results as these studies did not assess PFM use according to severity. However it may be alluded that the first question may have been influenced by participant bias and the second question actually reflects the participants true practises. Despite the assurance of anonymity, participants may have exaggerated their use of a PFM, in order to appear

compliant with published guidelines. It therefore appears that amongst participants using the PFM, it is being used to assess asthma exacerbation severity but not to the degree that was initially reported.

5.5 Patient reassessment

Both subgroups of the study were asked a series of questions in order to determine how they determine response to therapy of an asthma exacerbation.

5.5.1 No role for the PFM

Amongst the subgroup that did not use a PFM, participants were asked to identify one or more factors they would use in order to determine a response to therapy. Nine participants (60%) identified clinical assessment as one of the factors. Seven participants (46.7%) used patient self-assessment and change in vital signs. Five participants (33.3%) used clinical intuition.

Physician perception of clinical improvement

This has been identified as an inferior technique of patient reassessment by Rodrigo and Camargo.(7,50,53) Both authors recommended the use of a PFM to provide a static measurement of lung function which then can be compared to demonstrate a deterioration or improvement in the patient's condition. However conflicting findings were reported by Atta whose study found that physician assessment correlated significantly with lung spirometry.(90) Atta did limit this ability to experienced physicians, although the article did not define what variables made up an experienced physician.

It would appear that using clinical assessment is not an effective option available to all HCPs, as Atta demonstrated that its usefulness is determined by the experience of the treating HCP. However, this was also the most common technique chosen by the study participants.

Patient self perception of dyspnoea

Reck and Weiner exposed patients to metacholine challenge testing in order to assess what degree of dyspnoea they were able to identify.(40,41) Reck found that 60% of the participants were able to perceive a change in the degree of dyspnoea, however the remainder (40%) were unaware that their lung spirometry had been reduced by 20%. Similarly Weiner demonstrated that participants were only able to perceive dyspnoea once their spirometry had changed by 23%. Patient self-assessment was also found to be unreliable by Atta when compared to physician assessment or spirometry.(90) Patient self-perception is often used to assess therapeutic response in other medical conditions, which would account why this was possibly chosen by 47% of this subgroup. Overall it has been proven to be too unreliable to evaluate a therapeutic response in asthma exacerbations.

Observations of any changes in vital signs

Vital signs are considered to be too variable to be a reliable indicator of therapeutic response. Heart rate is too nonspecific to assess therapeutic response as its value may be confounded by other frequently encountered factors such as anxiety and SABA use.(7) The auscultation of breath sounds and wheezing have been shown to be impractical by a number of studies.(18,39,50) Similarly, respiratory rate is a poor indicator of lung function except when the measured

value is over 40 breaths per minute.(49) This is then associated with a deterioration in the patients condition. This may also be demonstrated by assessing for the use of accessory muscles, which has been shown to be associated with a poor lung function.(6) A deterioration in the level of consciousness does correlate with a premorbid state and implies an imminent life-threatening exacerbation.(4–6,8,76) Similar to patient self-perception, physical assessment was also selected by 47% of the participants. Although its use is limited by the nonspecificity of the clinical findings, it does provide HCPs who do not use the PFM, a form of static measurement to assess a therapeutic response.

Clinical intuition

This particular method of reassessment has not been well studied with regards to the management of asthma exacerbations, however Atta did find that physician assessments to be positively influenced as the experience of the HCP increased.(90) This was not a common choice amongst the participants, having only been chosen by 33%.

5.5.2 Role for the PFM

Participants in this subgroup that made use of a PFM were similarly asked how they assessed patient response to therapy. Fifty-one participants (89%) chose to reasses the patient using PFM readings with another physical assessment. Only six participants (11%) of this subgroup would use clinical assessment alone. None of these participants selected the choice of using PFM readings alone

PFM readings with physical assessment.

This particular approach is strongly supported by Rodrigo who states that the severity of an exacerbation or its response to therapy cannot be assessed by the patient's symptoms and physical examination alone.(50,53,67) He recommends that the only reliable and effective method of gauging response to therapy be by serial PFM readings together with a repeat physical examination. Similar recommendations are made in separate studies by McCarren and Goodacre.(64,69) However, Lim looked at the prevalence of patient relapse to an ED as his outcome, after they had been treated using either a PFM or physical assessment to gauge therapeutic response and found there to be no difference between the two methods.(91) The ACEP has also found there to be insufficient evidence proving that either method is superior to the other or has any effect on patient outcome.(71)

Clinical assessment

The benefits of using clinical assessment in this regard have already been discussed. Earlier, 13 participants (22.4%) in this subgroup that believed in the role of the PFM stated that they do not use the PFM. This number does not correspond with the six participants of this subgroup that use clinical assessment alone. The discrepancy is potentially affected by participation bias.

PFM readings alone.

This option was not chosen by any of the participants corresponding with the statements above that recommend using a combination of PFM readings together with a physical examination.

The evidence for evaluating patient response to therapy appears to be limited and no method has been conclusively proven to result in an improved patient outcome. Based on this survey, 51 of the 73 (81%) participants would use a PFM to gauge response to therapy. It is indeterminate whether the participants are not able to perform a PFM reading due to the perception of equipment shortages noted earlier.

5.6 Are peak flow meters being used to determine appropriate and safe disposition?

The reversibility of airflow limitation with therapy that partly defines asthma as a condition needs to be objectively assessed to determine further treatment requirements or need for admission.(92) Before this is done however, a period of time needs to pass in order to monitor the effect of treatment.

Observation Time

Thirty-nine percent of the participants claimed to use a period between 30 to 60 minutes before making a decision regarding the disposition of patients with an acute exacerbation. A similar amount (35%) of participants chose to observe patients for a period of 60 to 120 minutes. Few (11%) observe their patients for less than 30 minutes. The remaining 15% would observe patients for more than 2 hours.

In terms of the literature the most appropriate time period for observing the patient ranges between 15 minutes to an hour. A series of studies by Rodrigo *et al* in 1997, 1998 and 2009 ascertained that the ideal time to make a reassessment would be after 30 minutes.(50,53,67) This finding was supported by separate

studies by Camargo *et al,* Goodacre *et al* as well as being part of the recommendations by GINA.(6,7,69) The South African asthma guidelines also recommend the 30-minute mark as the best time for making a decision regarding patient disposition. Kelly *et al* found that a hour was the ideal time to make a reassessment for the purposes of disposition.(68) However only the one hour mark was used as a variable when comparing to the initial assessment at presentation. A recent study by Rodrigo performed more frequent reassessments at ten minute intervals after presentation and subsequently recommended that a reassessment could be made anywhere in the 15-60 minute interval after therapy had been initiated.(50) It appears that the participants that observe patients for less than 30 minutes and the 30-60 minute period account for 50% of the total study sample. A possible reason as to why the remaining 50% of the participants observe patients for a longer period of time may be related to the varying pathophysiology of asthma exacerbations of which two variants are described.(45) A period of less than 60 minutes observation would certainly be adequate to treat the occasional rapid onset asthma exacerbation, which responds rapidly to bronchodilator therapy. However the commoner slow onset asthma exacerbation reacts primarily to intravenous steroid therapy. The full benefits of steroids are only evident at approximately 4 hours post administration therefore the treating HCPs may be electing to wait for a longer period of time in order to ensure that the administered steroids have taken effect before making a decision regarding disposition.(92) Alternatively participants may be describing an ED that treats asthma exacerbations of a higher acuity for which prolonged therapy and observation may be necessary in a clinical decisions unit. The extended period of

observation may also be affected by a large number of patients succesively requiring the HCPs attention.

Factors determining disposition

The two subgroups of participants were asked a series of questions to determine which factors were being used by each as criteria for the safe disposition of the patient in the ED.

Most (80%) of the study participants identified the patient's response to therapy as the most important factor for determining a safe and appropriate disposition. In the subgroup that made use of the PFM, the majority (89%) used the patient's response to therapy as criteria for disposition. This number was similar to the 80% obtained from the subgroup that did not make use of the PFM. Kelly was able to establish that reassessing the patient one hour after initiation of therapy was a better indicator of admission or discharge as compared to the initial assessment.(68) Based on their own studies, similar recommendations were made by McCarren, Ortiz-Alvarez, Goodacre and Rodrigo.(48,50,53,64,67,69) Similarly, the South African adult asthma guidelines stress the importance of frequent reassessments.(5) In contrast, the South African paediatric guidelines place more emphasis on the initial assessment.(4) The participants of this study appear to be following the trend of subsequent reassessments, as it is more logical to assume that the patient's response to therapy would determine disposition.

Patient self-assessment was selected by 30% of the total participants. Almost half (47%) of the participants who did not use the PFM selected this as a variable, compared to 26% of the participants who did use a PFM. This method of

assessment has been previously discussed and is generally thought to be unreliable as patients are unable to objectively quantify their personal level of dyspnoea.(39–41) This statement was proven by Weiner who found that the patients perception of dyspnoea correlated with lung spirometry when therapy improved their lung function by 23%.(41) Comparatively more participants who did not make use of the PFM selected this as a criteria for disposition.

There is no evidence proving the superiority of the PFM or symptom-based assessment methods for the disposition of a patient.(70) Abisheganaden compared the two methods of assessment in a small ED based study with no difference in outcome.(72)

Participants who made use of the PFM were asked if a change in PFM readings was used to determine patient disposition. Thirty-nine (67%) of the participants reported that they would use recorded changes in PFM readings to make this decision. This is in keeping with studies where the benefit of having an objective measurement of lung function was demonstrated.(50,62,64)

These studies show that reversibility of airflow obstruction in asthma exacerbations may be objectively assessed with PFM readings that have improved by >50 L/min or >40% positive change of baseline.(7) These values may be incorporated into the variables that a HCP uses to decide whether the patient may now be safely discharged or alternatively admitted for further observation and management. The limitations of these studies are due to the inherent limitations of the PFMs themselves. PFM readings can be influenced by other factors such as poor effort, incorrect technique or malfunctioning PFMs.(22,25,27–29) The use of the PFM is also limited in children.(38)

The remaining participants who did not make use of serial PFM readings were probably limited to one PFM reading and / or their clinical examination.

Participants who did not use the PFM were asked if they utilised an improvement in vital signs to determine patient disposition. Half (53%) of this subgroup of participants reported using an improvement of vital signs when making their decision regarding disposition. The remainder are probably making use of the factors identified earlier such as patient and physician assessments. Although the use of vital signs is considered to be too variable for use it remains the only way of treating children that do not use a PFM.(4,7,18,38,48–50,66) Additionally, Abisheganad was unable to demonstrate any difference in patient outcome when a PFM was not used to determine patient disposition.(72)

5.7 Strengths of this study

This was a prospective study on the use of peak flow meters in the ED, which had never before been performed on an ED population in South Africa. The only other local study on peak flow meters was one performed on General Practitioners in Lenasia and Soweto, Johannesburg.

The study identified that PFM and individuals that utilised a PFM were not using nomograms correctly as only a quarter of the subgroup were aware of the correct variables required to correlate a PFM reading.

5.8 Weaknesses of this study

Participants who were not fluent in English may have been reluctant to complete the questionnaire as no pilot study was done and as a result any ambiguity or difficult questions may have been overlooked.

By selecting the EMSSA symposium for the purposes of data collection, the participants were exposed to an unforeseen limitation of time. The information sheet declared that the questionnaire would take approximately 20 minutes to complete. Unfortunately the period between lectures at the symposium varied between 5 to 15 minutes which may have biased the responses towards the end of the questionnaire or limiting the participant's ability to complete it in one sitting thus making it easier not to complete. Additionally the data collection period was time limited to the duration of the symposium. There was also no possibility of a follow up survey to be done to participants who did not respond in the initial survey.

The subjective nature of the questionnaire may also have allowed for the possibility of potential bias to occur. Participants were required to declare, albeit anonymously their use or no-use of a PFM. They may have exaggerated their use of a PFM, in order to appear compliant with published guidelines.

The practical question requiring the participant to correctly describe the method of using a PFM was never validated. Although there are studies performed on this concept, no copies of any validated questionnaires could be obtained and as a result a new one had to be designed. Another limitation was the position of this

particular question in the questionnaire. By being at the very end of the questionnaire, participants may not have given this question an appropriate amount of time or thought.

Finally this study did not assess if participants using a PFM were using the PFM readings to assess for a response to therapy with a method not prescribed by the guidelines.

Chapter 6 CONCLUSION

This prospective study of ED-based HCPs disclosed that 61.7% of the sample population were making use of the PFM. Of the study participants that utilised a PFM, only 46% were assessed as being able to do so correctly with just 25% knowing how to correlate the readings with an appropriate nomogram. Participants from both public and private sector EDs perceived there to be shortages in their respective EDs in terms of equipment related to the use of the PFM, which may hace impacted the usage thereof.

Public sector participants identified an unavailability of either PFMs, nomograms or disposable mouthpieces as factors which affected their ability to use a PFM to its full effect while participants from the private sector perceived there to be a lesser number of paediatric PFMs available.

Participants that were utilising the PFM were doing so to assess for severity, gauging response to therapy and determining disposition.

The gold standard for measuring lung function is spirometry and the easiest and cheapest method of doing this in the ED is to use a PFM. The PFM is known to be a non-standardised instrument whose readings are not interchangeable with other models. Its correct utilisation is user dependant on factors such as available equipment, patient effort, correct technique and interpretation of readings with an appropriate nomogram. These readings have been shown to be unreliable leading to an underestimation of the patients lung function in the ED, which may result in excessive patient treatment.

The ED is a unique enviroment in which the use of a PFM mandated by the current asthma exacerbation guidelines is debatable. The PFM has never been shown to be of benefit to either adult or paediatric patient outcome in the ED management of acute asthma exacerbations. It is underutilised by participants of this study as well as clinicians from family medicine, paediatrics and emergency medicine, both locally and internationally.

In light of this and the above findings, it is recommended that these guidelines together with the use of the PFM be reviewed by the SEPs who are managing the acute asthma exacerbations in the ED.

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APPENDIX 1

Information Leaflet

Management of Asthma Exacerbation in the ED

Information Leaflet

INTRODUCTION

You are invited to volunteer for a research study. This information leaflet is to help you to decide if you would like to participate. Before you agree to take part in this study you should fully understand what is involved. If you have any questions, which are not fully explained in this leaflet, do not hesitate to ask the investigator. You should not agree to take part unless you are completely happy about all the procedures involved.

WHAT IS THE PURPOSE OF THIS STUDY?

The aim of this study is to determine the Management of Acute Asthma Exacerbations in the Emergency Department with the available resources. Information gathered from this research project will improve our understanding of Asthma and may help reduce the morbidity associated with this condition.

WHAT IS THE DURATION OF THIS STUDY?

If you decide to take part you will be one of approximately 114 participants. It will take approximately twenty minutes for you to complete the questionnaire.

EXPLANATION OF PROCEDURES TO BE FOLLOWED

This study involves completing a questionnaire.

It is important that you answer the questionnaires as accurately and as honestly as possible.

HAS THE STUDY RECEIVED ETHICAL APPROVAL?

This research study protocol has been submitted to the Faculty of Health Sciences Research Ethics Committee, University of Witwatersrand and written approval has

been granted by that committee. (Protocol approval number M121025 - Appendix 3).

WHAT ARE YOUR RIGHTS AS A PARTICIPANT IN THIS STUDY?

Your participation in this study is **entirely voluntary** and you can refuse to participate or **stop** at any time without stating any reason.

MAY ANY OF THESE STUDY PROCEDURES RESULT IN DISCOMFORT OR INCONVENIENCE?

This is solely a questionnaire-based study.

WHAT ARE THE RISKS INVOLVED IN THIS STUDY?

Participation in this study does not bear any risk.

SOURCE OF ADDITIONAL INFORMATION

If at any time you have any questions about the study, please do not hesitate to contact the investigator: Dr. Pano Parris. My telephone number is 076 4244887 and my email address is: parris@iafrica.com

CONFIDENTIALITY

All information obtained during the course of this study is strictly confidential. Data that may be reported will not include any information that identifies you as a participant.

Questionnaire

If you are not employed in South Africa, which country are you from?

_____

If you are working in SA, which province are you working in?

_____

Please answer the questions below relating all answers to the Emergency Department (ED), where you spend most of your time working.

(Place tick in appropriate Box where relevant)

Which ED is the one you are describing?

Private Sector ED	
Public Sector ED – Primary Healthcare Facility	
Public Sector ED – Secondary Healthcare Facility	
Public Sector ED – Tertiary Healthcare Facility	
Public Sector ED – Quaternary Healthcare Facility	

What category of Health Professional are you registered as?

Medical	
Nursing	

What Post Graduate medical or nursing qualifications, if any, do you have?

_____

How long have you been practicing?

0 – 5 Years	
6 - 10	
11 - 15	
16 - 20	
>21	

Do you believe that the Peak Flow Meter plays a role in the ED management of Acute Asthma Exacerbations?

Yes		**No**	

If you have answered "Yes" to the above question, please turn to page 8 and continue.

If you have answered "No" to the above question, please answer the questions up to and including page 7.

Are there written protocols for the management of acute asthma exacerbations in your ED?

Yes		**No**		**Don't Know**	

If they exist, when were the protocols last updated?

Don't Know		**<1 Year**		**1 -2**		**3- 5**		**> 6**	

Is there an Adult Peak Flow Metre (PFM) in your ED?

Yes		**No**		**Don't Know**	

Is there an Adult PFM chart in your ED?

Yes		**No**		**Don't Know**	

Is there a Paediatric PFM in your ED?

Yes		**No**		**Don't Know**	

Is there a Paediatric PFM Chart in your ED?

Yes		**No**		**Don't Know**	

Are there disposable mouthpieces for the PFM for use in your ED?

Yes		**No**		**Don't Know**	

Why do you not use the PFM?

(Mark more than one if necessary)

Its use is not based on Evidence Based Guidelines	**Yes**		**No**	
It's a historical relic	**Yes**		**No**	
Patients are treated with maximal therapy anyway on presentation.	**Yes**		**No**	
Clinical intuition is more reliable than PFM readings	**Yes**		**No**	
Waste of precious time	**Yes**		**No**	
Waste of resources	**Yes**		**No**	
It's never available in the ED	**Yes**		**No**	

If you use clinical features, which do you use to assess severity?

(Tick the 5 most important)

Respiratory Rate	
Heart Rate	
Level of Consciousness	
Phonation	
Patient Positioning	
Work of Breathing	`
Breath Sounds	
Pulsus Paradoxus	
Blood Pressure	
Oxygen Saturation	

When do you do a Chest X-ray for a patient presenting with an acute asthma exacerbation?

In all patients	
Mild Exacerbations	
Moderate Exacerbations	
Severe Exacerbations	
Never	

When would you do an Arterial Blood Gas (ABG) in Adults for a patient presenting with an acute asthma exacerbation?

In all patients	
Mild Exacerbations	
Moderate Exacerbations	
Severe Exacerbations	
Never	

When would you do an Arterial Blood Gas in Children for a patient presenting with an acute asthma exacerbation?

In all patients	
Mild Exacerbations	
Moderate Exacerbations	
Severe Exacerbations	
Never	

When treating an acute asthma exacerbation, in what order of priority would you consider the following Blood Gas values to be in managing a patient with an acute asthma exacerbation?

pH	
PCO_2	
PO_2	
Hb	
SATS	

When treating an acute asthma exacerbation, is a Venous Blood Gas (VBG), an acceptable alternative to an ABG?

Yes		**No**		**Don't Know**	

If yes, why?

Less painful to the patient	**Yes**		**No**	
Similar readings for pCO2 levels	**Yes**		**No**	
Similar readings for pH readings	**Yes**		**No**	
Dissimilar readings for pO2 levels	**Yes**		**No**	
Dissimilar readings for saturation levels	**Yes**		**No**	

What do you use to determine a therapeutic response to your initial treatment of Acute Asthma Exacerbations?

Patient self-assessment	**Yes**		**No**	
Clinical Assessment	**Yes**		**No**	
Clinical Intuition	**Yes**		**No**	
Change in vital signs	**Yes**		**No**	
Response to therapy	**Yes**		**No**	

How long are patients with acute asthma exacerbations observed for in your ED, before a decision is made regarding disposition (Admission / Discharge)?

< 30 Minutes	
30 - 59 Minutes	
60 – 120 Minutes	
121 – 180 Minutes	
> 180 Minutes	

What factors most influence the above decision?

Patient self-assessment	**Yes**		**No**	
Patient wants to stay / go home	**Yes**		**No**	
Clinical Intuition	**Yes**		**No**	
Improvement of vital signs	**Yes**		**No**	
Response to Therapy	**Yes**		**No**	

Do you think that the lack of a PFM reading may pose a medico legal liability?

Yes		**No**	

Do you think patients are actually able to do a Peak Flow when they present to the ED with an acute asthma exacerbation?

Yes		**No**	

Do you think patients want to do a Peak Flow, when they present to the ED with an acute asthma exacerbation?

Yes		**No**	

Should patients be discharged with Peak Flow Metres to use at home?

Yes		**No**	

Do you think patients would be compliant to perform Peak Flow Metre readings at home?

Yes		**No**	

Are PFM readings done at home of any use to you, in the ED management of an acute asthma exacerbation?

Yes		**No**	

Have you done the AMLS® or APLS® course?

Yes		**No**	

Are you aware that the use of the PFM is recommended as part of evidence based guidelines?

Yes		**No**	

Thank you for taking the time to complete this Questionnaire.

You have selected that the PFM plays a role in the ED, please answer the following:

Do you use the PFM in your management of asthma exacerbations?

Yes		**No**	

Are there written protocols for the management of acute asthma exacerbations in your ED?

Yes		**No**		**Don't Know**	

If they exist, when were the protocols last updated?

Don't Know		**<1 Year**		**1 -2**		**3 - 5**		**> 5**	

What patient specific information do you think is required to make a correct Peak Flow Metre (PFM) reading?

Height	
Weight	
Age	
Gender	
None of the above	

Is there an Adult Peak Flow Metre (PFM) in your ED?

Yes		**No**		**Don't Know**	

Is there an Adult PFM chart in your ED?

Yes		**No**		**Don't Know**	

Do you correlate the Peak Flow readings with the chart?

Yes		**No**	

Is there a Paediatric PFM in your ED?

Yes		**No**		**Don't Know**	

Is there a Paediatric PFM Chart in your ED?

Yes		**No**		**Don't Know**	

Do you correlate the Peak Flow readings with the chart?

Yes		**No**	

Are there disposable mouthpieces for the PFM for use in your ED?

Yes		**No**		**Don't Know**	

Who performs the Peak Flow Metre Assessment?

Triage Nurse	
Nurse attending to the patient	
Doctor attending to the patient	

Who do you think should perform the Peak Flow Metre assessment?

Triage Nurse	
Nurse attending to the patient	
Doctor attending to the patient	

Why do you use the Peak Flow Metre?

(Mark more than one if necessary)

Its use is based on Evidence Based Guidelines	**Yes**		**No**	
Its use is mandated by the department protocols	**Yes**		**No**	
It's clinically useful in patient management	**Yes**		**No**	
It's a chargeable procedure	**Yes**		**No**	

In what circumstances, do you use a PFM to classify patients according to their presenting severity?

Mild Exacerbations	**Yes**		**No**	
Moderate Exacerbations	**Yes**		**No**	
Severe Exacerbations	**Yes**		**No**	
Life-threatening	**Yes**		**No**	

Do you ever initiate therapy without the use of a PFM?

Yes		**No**	

When?

Mild Exacerbations	**Yes**		**No**	
Moderate Exacerbations	**Yes**		**No**	
Severe Exacerbations	**Yes**		**No**	
Life-threatening	**Yes**		**No**	

When using clinical features, which do you use to assess the severity of the acute asthma exacerbation?

(Tick the 5 most important)

Respiratory Rate	
Heart Rate	
Level of Consciousness	
Phonation	
Patient Positioning	
Work of Breathing	`
Breath Sounds	
Pulsus Paradoxus	
Blood Pressure	
Oxygen Saturation	

When do you do a Chest X-ray in a patient with an acute asthma exacerbation?

In all patients	
Mild Exacerbations	
Moderate Exacerbations	
Severe Exacerbations	
Never	

When would you do an Arterial Blood Gas (ABG) in an adult with and acute asthma exacerbation?

In all patients	
Mild Exacerbations	
Moderate Exacerbations	
Severe Exacerbations	
Never	

When would you do an Arterial Blood Gas in a child with an acute asthma exacerbation?

In all patients	
Mild Exacerbations	
Moderate Exacerbations	
Severe Exacerbations	
Never	

When treating an acute asthma exacerbation, in what order of priority would you consider the following Blood Gas values to be in managing a patient with an acute asthma exacerbation?

pH	
PCO_2	
PO_2	
Hb	
SATS	

When treating an acute asthma exacerbation, is a Venous Blood Gas (VBG) an acceptable alternative to an ABG for monitoring purposes?

Yes		**No**		**Don't Know**	

If yes, why?

Less painful to the patient	**Yes**		**No**	
Similar readings for pCO2 levels	**Yes**		**No**	
Similar readings for pH readings	**Yes**		**No**	
Dissimilar readings for pO2 levels	**Yes**		**No**	
Dissimilar readings for saturation levels	**Yes**		**No**	

What do you use to determine a therapeutic response to your initial treatment of Acute Asthma Exacerbations?

Change in PFM Reading		**Clinical Assessment**		**Both**	

How long are patients with acute asthma exacerbations observed for in your ED, before a decision is made regarding disposition (Admission / Discharge)?

< 30 Minutes	
30 - 59 Minutes	
60 – 120 Minutes	
121 – 180 Minutes	
> 180 Minutes	

What factors most influence the above decision regarding patient disposition?

Patient self-assessment	**Yes**		**No**	
Patient wants to stay / go home	**Yes**		**No**	
Clinical Intuition	**Yes**		**No**	
Change in Peak Flow readings	**Yes**		**No**	
Response to Therapy	**Yes**		**No**	

Are PFM readings an important medico-legal record?

Yes		**No**	

Do you think patients are actually able to do a Peak Flow when they present to the ED with an acute asthma exacerbation?

Yes		**No**	

Do you think patients want to do a Peak Flow, when they present to the ED with an acute asthma exacerbation?

Yes		**No**	

Should patients be discharged with Peak Flow Metres to use at home after presenting for an acute asthma exacerbation?

Yes		**No**	

Do you think patients would be compliant to perform Peak Flow Metre readings at home if instructed to do so?

Yes		**No**	

Are PFM readings done at home of any use to you, in the ED management of an acute asthma exacerbation?

Yes		**No**	

Choose the correct statements and number in sequence, how you would instruct an adult patient to utilize a PFM.

	Use the peak flow meter in the position of comfort for the patient.
	Place the peak flow meter in the mouth, with the tongue under the mouthpiece.
	Take in as deep a breath as possible.
	Blow out as hard and fast as possible
	The peak flow meter should read zero or its lowest reading when not in use
	Repeat the process two more times. Write down the highest number obtained.
	Place the peak flow meter in the mouth. The position of the tongue is irrelevant.
	One reading is sufficient in an emergency situation
	Use the peak flow meter while standing up straight.
	Close the lips tightly around the mouthpiece.

Did any of the following educational elements make you realize the importance of the uses of the PFM?

Undergraduate training

Yes		**No**	

Postgraduate training

Yes		**No**	

AMLS®

Yes		**No**	

APLS® ®

Yes		**No**	

Thank you for taking the time to complete this Questionnaire.

APPENDIX 2: Human Research Ethics Committee clearance

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Dr Panayiotis Parris

CLEARANCE CERTIFICATE	**M121025**
PROJECT	The Use of Peak Flow Meters in Acute Asthma in the Emergency Department
INVESTIGATORS	Dr Panayiotis Parris.
DEPARTMENT	Division of Emergency Medicine
DATE CONSIDERED	26/10/2012
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 09/11/2012 **CHAIRPERSON** .....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Dr Zeyn Mohamed

DECLARATION OF INVESTIGATOR(S)
To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

APPENDIX 3 Consent EMSSA Research Committee

Emergency Medicine Society of South Africa (NPC)

8 November 2012

Dr P Parris
BY EMAIL: parris@iafrica.com

Re: Application for research at the EMSSA 2012 Emergency Medicine Symposium: The use of peak flow meters in acute asthma in the emergency department.

Your application to the EMSSA Research Committee refers.

We have received the following documents in this regard:

- Complete Protocol with appendices
- Provisional HREC Clearance from the University of the Witwatersrand
- Proof of University Approval of the protocol from the University of the Witwatersrand

The EMSSA Research Committee has reviewed your application and supporting documentation.

We hereby wish to inform you that the EMSSA Research Committee has approved your application to conduct your research at the upcoming EMSSA 2012 Emergency Medicine Symposium.

Kindly provide the EMSSA Research Committee with a copy of your Research Report once completed.

Yours sincerely

Prof Roger Dickerson
MBBCh (Wits) Dip PEC (SA) DA (SA) FCEM (SA) Cert Critical Care (SA) ATCL (UK)

On Behalf of the Research Committee
Emergency Medicine Society of South Africa

Chair: Dr Melanie Stander chair@emssa.org.za
Vice-chair: Prof Roger Dickerson
Secretary: Ms Mande Toubkin
www.emssa.org.za
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